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FOREST INSECT CONDITIONS IN THE CENTRAL ROCKY MOUNTAINS AND THE GREAT PLAINS, 1952

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INTRODUCTION

A summary of forest insect conditions in the Central Rocky Mountains and the Great Plains is reported annually by the Fort Collins field laboratory of the Division of Forest Insect Investigations, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture. The Central Rockies and the Great Plains coincide with U. S. Forest Service Region 2 and the plains country of Region 3.[1] Forest insect conditions are determined by way of surveys, the results of which are assembled and analyzed by the Fort Collins laboratory.

The preparation of this annual report on forest insect conditions is part of the directive from the Secretary of Agriculture who is authorized by the Forest Pest Control Act of 1947 (Public Law 110) to detect and appraise infestations of destructive forest insects, to determine control measures, and to apply those measures that are deemed best toward protecting and preserving the forest resources of the country from damage by forest insects.

SURVEY TYPES

Surveys of forest insect conditions within the Central Rockies and the Great Plains are made by the Fort Collins laboratory and its cooperating agencies, the owners, managers, and users of the forests, public and private. Detection surveys, generally unplanned, are the initial observations of insect infestations in forested areas. They are made by foresters during the course of their everyday activities; they may be made by the range inspector on horseback or by the district ranger flying the forest on fire patrol. They may be made by the vacationer camping in a wilderness area. However made and by whomever made, the reports of these detection surveys are most valuable. Received at the laboratory they are analyzed and, when the situations warrant, are followed up with reconnaissance and appraisal surveys made by technicians from the laboratory or trained personnel of the cooperating agencies under supervision of the laboratory.

A reconnaissance survey is made to determine specifically the cause of the infestation, the amount of damage being done, and the trend of the infestation. It forms the basis for deciding whether or not measures of control should be undertaken. A reconnaissance survey, while planned, as a rule is only an extensive examination of the situation. On the other hand, an appraisal survey, also a planned survey, is an intensive inventory made systematically either to assemble detailed information regarding an outbreak for control planning or to determine the effectiveness of a control project.

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[1] The Southern Rocky Mountains, Forest Service Region 3, were part of the Fort Collins territory until September 1. On that date a new field laboratory to direct the survey activities in that Region was established at Albuquerque, New Mexico.

For most effective use of reconnaissance and appraisal surveys, a concise report is prepared immediately upon termination of each survey. The report is a complete accounting of the infestation together with suggestions and recommendations regarding control. Copies of the report are forwarded to the forest manager for his information and consideration. Decisions on the action to be taken are then made by the forest manager, generally, after consultation with the survey organization.

SURVEY RESULTS, GENERAL

Reconnaissance and appraisal surveys of forest insect conditions in the Central Rockies and the Great Plains were necessarily at an undesirable but unavoidable minimum during 1952. The technical manpower of the laboratory had to be directed almost fulltime to the Engelmann spruce beetle control project on the White River, Arapaho, and Routt National Forests and surveying the neighboring spruce type. Early allocations of funds for the spruce beetle project in 1952, however, made for good organization of and follow-through by the survey crews and camp entomologists on the project itself and allowed some time and personnel for other essential reconnaissance and appraisal surveys throughout the territory. Unexpected but most welcome aid in getting at these essential surveys came from the rapid development and termination of the spruce beetle control project, direct results of the pronounced reduction in the spruce beetle population and the apparent decline in the beetle's aggressiveness.

It is seemingly fortunate that no overly alarming situation developed, even on the Roosevelt and Bighorn National Forests where the Black Hills beetle outbreaks continued with only slight build-up and did not blow up as both epidemics might have, that on the Roosevelt especially. Since no control work in 1952 was done on either Forest, the major obstruction to a blow-up probably was the 1950-1951 winter kill of the beetle populations and a consequent setback to the epidemics. The spruce beetle project mentioned above did not forestall smaller limited control programs in other forested areas of the territory. Possibly it had the opposite effect. There was an apparent added active desire on the part of the forest officers to prevent insects from building up to epidemic levels.

While forest insects in the territory during 1952 have not been quiescent, they have not been unduly destructive. Analyses of the survey data does not suggest or forecast more than a "normal" amount of infestation for 1953. Some of this seeming optimism, no doubt, is a result of the feeling of relief and relaxation experienced when the Engelmann spruce beetle outbreak was drastically changed, after 10 years, from a high epidemic level to a near endemic level. That all is not complacent is brought out in the descriptions of localized insect build-ups and the suggestions that control measures be taken to suppress specific outbreaks.

While some few epidemic situations now exist, the insects not at alarming population levels must be respected for their potentialities. In light of the bark beetle and defoliator outbreaks of recent years and the costly though successful control projects, forest insects more and more are being recognized as major factors in good forest management. Forest owners and operators alike have found that insect outbreaks can seriously disrupt

well-made plans and cause great financial loss. The ultimate, therefore, is for forest management, through insect control, to quell incipient outbreaks and otherwise keep destructive insect populations at endemic levels. A means of reaching this goal is through maintenance control, the suppression of destructive insects before they get out of hand.

Maintenance control, in practice, combines observation with action. Maintenance control may take the form of salvage logging of infested trees by a timber operator in the neighborhood, even at an immediate financial sacrifice to the operator. It may be done by a forest officer whose truck is equipped with apparatus and chemicals for treating individual or small groups of infested trees as he finds them during the course of his other duties. Or, when such treating is not feasible, he may record the trees and treat them later, on a small control project basis.

SURVEY RESULTS, SPECIFIC

Engelmann spruce beetle, Dendroctonus engelmanni, in Engelmann spruce

The Engelmann spruce beetle in one outbreak from 1939 to 1952 killed over 4 billion board feet of spruce in Colorado. This was the nation's greatest single recorded bark beetle outbreak. It was brought under control in 1952 through the combined efforts of (1) man, by the use of toxic chemicals and salvage logging, and (2) the beetle's natural enemies, insectivorous birds and mammals, parasitic and predaceous insects, and extremes in weather. "Brought under control" means, in fact, that the Engelmann spruce beetle population in Colorado has returned to a near endemic level, that no spruce beetle control project, as it recently has been considered, need be proposed for 1953. There now are no beetle-attacked standing trees on the project area that will need to be chemically or otherwise treated; however, there are some road-clearance trees and logs and some trap logs and felled trees that will need to be chemically treated or salvaged by logging. Whether trap logs and trap trees will be used in 1953 to absorb an emerging resident population of adult beetles and whether green trees will be attacked in mid-1953 by these resident beetles will influence the need for a control project. Such a determination will be made upon analyses of the results of the 1953 surveys.

No recorded extreme cold snaps or other abnormal conditions were reported for the winter 1951-1952. However, a follow-up of the 1951 surveys was deemed advisable before 1952 plans for the Colorado spruce beetle control project could be completed. Consequently, a two-weeks' survey in March and April was made by a crew travelling by mechanized sled, snow shoes, and skiis. Representative blocks of the project area were visited; the results of the fall 1951 surveys were confirmed. Considering the potentialities of the spruce beetle itself as well as its natural enemies, it was decided to make surveys, during the control operation, slightly ahead of the control crews so no blocks of infestation would be overlooked by the treating personnel and, also, to avoid unnecessary treating. These surveys began in early June. They served the treating camps well by keeping the camps' infestation maps up-to-date. The surveys for 1952 attacks began when the beetle flight was at its peak. The data from these surveys, then, were supplied to the control personnel for immediate consideration. Thus, surveys and control worked as a team.

Surveys outdistanced control toward the final stage of the program. New attacks were relatively few, the attacks themselves were weak. Scouting, the phase of surveying which locates new or previously unobserved outbreak areas, found few at an epidemic level; surveying, the phase which provides the attack-tree estimates for control, gradually disappeared from the agenda. In all, about 2.4 million gross acres of forest land in the project area were scouted and surveyed; the insect's population came to an endemic level; the control project was brought to a successful termination.

Control, although outdistanced by surveys, was ended on August 22, 1952 after only 227,859 beetle trees of an estimated 400,000 were treated; the beetle populations in the untreated trees were being drastically reduced by woodpeckers and a rapidly growing parasite population.

A program to control two areas of Engelmann spruce beetle outbreak on the San Juan National Forest was initiated in 1952. One was in and adjacent to a sale area where the operator cooperated in salvage logging and the Forest Service chemically treated cull logs and green stumps; the other, though in a stand scheduled for sale, had no access road for salvage logging, hence the infested trees had to be treated chemically for control. In the first, 1,762 trees were involved, in the second, 2,420. Survey estimates of spruce beetle attacks on the San Juan are relatively light and, except for continued control by logging infested trees, no control program is suggested. Reconnaissance surveys will be made in the known and suspected areas of spruce beetle kill following beetle flight in 1953.

On the Rio Grande National Forest a spruce beetle outbreak at Wolf Creek Pass has been reduced to an endemic level through control operations in 1952 by chemically treating or salvage logging 2,108 infested trees. Some infested logs left along the access road will need to be treated or removed before beetle flights in 1953.

Only endemic levels of the spruce beetle were in evidence in or near spruce blow-downs and slides in the Rocky Mountain National Park and the Roosevelt and Shoshone National Forests.

Engelmann spruce beetle, Dendroctonus engelmanni, in lodgepole pine

As in 1951 the lodgepole pines attacked by the Engelmann spruce beetle were not tallied by the survey crews. Some lodgepoles were attacked but unsuccessfully. Only several years before the loss of lodgepole to spruce beetle attacks had amounted to over half a billion board feet.

Black Hills beetle, Dendroctonus ponderosae, in ponderosa pine

The Black Hills beetle outbreak on the Roosevelt National Forest has remained static since last year. An estimate of 8,000 ponderosa pines were attacked in 1952. As proposed but not carried out last year, control measures should be initiated so as to reduce the outbreak to an endemic level. One area in particular, a newly-developed reservoir-recreation site on the Boulder District with 200 infested trees should be given high priority on control.

The outbreak of the Black Hills beetle in ponderosa pine on lands in and neighboring the Bighorn National Forest has moved north on both sides of the east boundary and into some high-use private lands. The outbreak had been reduced by the cold snaps of 1950-1951 from 35,300 beetle trees, ponderosa and limber pines, to an estimated 7,500 trees. However, no control was initiated in 1951 or 1952 when the epidemic might have been stopped. The residents of Story, Wyoming have become alarmed at the invasion and consequent tree mortality and have taken direct action toward cleaning up the outbreak in the immediate Story area, on both private and State lands. Most of the beetle trees will be logged and the slabs containing the insects will be burned at the mill. While only 346 infested trees are involved in this portion of the outbreak, an estimated 1,000 more infested trees adjoining Story should be included in the control program. These are on private, State, and Federal lands.

On the Harney and Black Hills National Forests the outbreak of Black Hills beetle in ponderosa pine has been reduced through persistent and concerted control efforts from a high epidemic level in 1948 to an endemic status. Control projects carried out in 1952 resulted in the treating of 193 and 335 trees, respectively, on the two Forests. Except for some attacked snags and culls left after salvaging in a narrow blow-down strip in the northwestern corner of the Black Hills Forest, the attacked trees are scattered. Salvage logging of these scattered trees is not feasible. There are an estimated 390 attacked trees on the Harney and 500 on the Black Hills. Maintenance control operations will be continued on these two Forests.

The Black Hills beetle has developed into epidemic proportions in virgin ponderosa pine on the Uncompahgre National Forest. Much of the infestation is in inaccessible country on the Norwood District and salvage logging is not feasible. In a few areas loggers will be able to remove beetle trees. An estimate of 1,100 infested trees should be removed or chemically treated.

Approximately 800 ponderosa pines on the San Isabel National Forest were successfully attacked by the Black Hills beetle in 1952; only 96 trees infested in 1951 were treated. Parts of the infestation are high-use areas where each tree is valuable and important. Control operations are advisable.

Small but potentially serious epidemics of Black Hills beetle on the San Juan National Forest were surveyed. An estimated 1,200 infested ponderosa pines make up the infestation. These should be treated chemically or logged for beetle control in 1953. The scattered nature of the attacked trees may preclude much salvage logging. Two hundred and twenty 1951-attacked pines were treated in 1952.

The Black Hills beetle is at epidemic levels in ponderosa pine on two portions of the Rio Grande National Forest; 178 1951-attacked trees were treated. The overall estimate of newly-infested trees, however, including both the above areas, is only 500. Control of this infestation is advisable.

A very minor epidemic of the Black Hills beetle occurs on the Pike National Forest; there are approximately 125 beetle-infested ponderosa pines on the South Platte District. A small but unestimated group of infested pines was reported on the Bailey District. Control by salvage logging or chemical treatment should be carried out.

On both the Black Forest and the Denver Mountain Parks area in Colorado the Black Hills beetle is at an endemic level. These are high-use forested areas of mixed private, municipal, and State ownership, which demand good detection surveys and cooperative maintenance control.

Douglas-fir beetle, Dendroctonus pseudotsugae, and fir engraver, Scolytus ventralis, in Douglas-fir

The cold snaps during the winter 1950-1951 were responsible for a drastic reduction in the Douglas-fir beetle population in the outbreak areas of the Roosevelt National Forest and the Rocky Mountain National Park. Fortunately, the endemic situation in these two areas has persisted.

On the San Juan National Forest a gradual build-up of the Douglas-fir beetle population appears to be occurring. An aerial reconnaissance survey in July revealed moderate- to large-size groups of beetle-infested Douglas-fir. A ground reconnaissance survey in October confirmed the July observations. Both the Douglas-fir beetle and the fir engraver were causing high Douglas-fir mortality, generally in inaccessible parts of the Forest. It appeared that the Douglas-fir beetle preferred attacking the large, over-mature trees while the fir engraver selected smaller trees possibly weakened by drought. No appraisal survey was made and until one is made, no suggestion for control is advanced.

Turpentine beetle, Dendroctonus valens, in pine

The turpentine beetle at the Nebraska National Forest is causing considerable damage to Scotch, Austrian, ponderosa, and jack pines. The insect appears to be increasing in aggressiveness. An estimated 150 trees are infested and need to be treated.

Spruce budworm, Choristoneura fumiferana, on Douglas-fir, fir, and spruce

The status of the spruce budworm in the Central Rockies has been relatively light, so much so that in very recent years the defoliator has attracted practically no attention. Its potentialities, however, are great and it is important that incipient outbreaks be recognized, reported, and analyzed. The application of control measures at the onset of an outbreak is good insurance against a probable heavy loss of timber. Too, the application of control in the instance of a light infestation in a mature stand can prevent very severe permanent damage to the understory, the trees that are to be the new crop following harvest of the overstory and the trees that can be harvested for the ornamental tree or Christmas tree markets. The returns from sales of ornamental and Christmas trees can more than pay for control.

Sawfly, Neodiprion sp., on pine

Damage to pinon by a sawfly at the Colorado National Monument was practically nil in those parts of the area where DDT was mist-blown in 1952. The defoliation in the unsprayed areas was less severe than in previous years. Whether or not a control program is carried out in 1953 will depend on the spring surveys.

The sawfly feeding on pinon on the Mesa Verde National Park appears to be almost non-existent. Here, too, control will be dependent upon spring surveys.

Pinon scale, Matsucoccus acalyptus, on pine

At the Colorado National Monument and the Mesa Verde National Park the pinon scale may be increasing in severity. It does not appear to have been reduced. Control measures should be attempted.

Tip moth on pine

An undetermined tip moth in pinon at the Colorado National Monument is causing severe damage to the current year's growth. The infestation has spread from the headquarters area to other parts of the Monument. Attempts at control are advisable.

The tip moths, Rhyacionia neomexicana and R. frustrana bushnelli, serious in the ponderosa pine plantations on the Nebraska National Forest, are apparently at a low population level.

Great Basin tent caterpillar, Malacosoma fragilis, on aspen

A widespread and severe defoliation of aspen by the Great Basin tent caterpillar is occurring on private and public lands in and near the San Isabel and Rio Grande National Forests. The infestation has been in progress for several years; no control measures have been taken against the pest. Some tree mortality is occurring and numerous complaints have been made by recreationists. An estimated 25,000 to 35,000 acres are involved. Approximately 5,000 of the infested acres on the San Isabel Forest border extensive stands of aspen on the Walsenburg, Trinidad, La Veta, Colorado watershed. A heavy population of caterpillars on that area would create a serious water pollution problem.

Management of aspen for commercial use and the increase in recreational use plus the probable water-pollution hazard will dictate the program for control of the defoliator.

Great Basin tent caterpillar feeding on bitterbrush, mountain mahogany, and serviceberry is widespread on the Mesa Verde National Park. It is at an endemic level but a continuing threat to the aesthetics of the Park.

Poplar and willow borer, Cryptorhynchus lapathi, in willow

The poplar and willow borer, a weevil, in recent years has built up to epidemic proportions on the Black Hills National Forest. It has caused extensive damage to willows bordering meadow streams. In many places most of the older and larger stems have been killed. The insect should be further investigated and means of feasible control determined.

Miscellaneous

The ponderosa twig moth, Dioryctria ponderosae, reportedly is increasing in numbers on Austrian and Scotch pines at the Nebraska National Forest. Control measures should be applied.

A tussock moth, possibly Olene sp., was found feeding on ponderosa pine near Chadron State Park, Nebraska. The extent or intensity of its feeding has not reported. Attempts at control will be suggested should the insect become seriously destructive.

Toumeyella numismaticum, the pine tortoise scale is suspected of damaging jack and Scotch pines on the Nebraska National Forest.

The pine needle scale, Phenacaspis pinifoliae, was found on Scotch pine at the Nebraska National Forest. The infestation is apparently very light.

Engraver beetles, especially Ips spp., are causing very little damage within the laboratory's territory. Slight flare-ups of engravers have occurred, generally following right-of-way tree cutting, on the Mesa Verde National Park and the Colorado National Monument. Freshly-felled trees and slash should be removed before the beetle population builds up.

An undetermined oak looper appeared at an endemic level on the Mesa Verde National Park. Control measures should be considered if the insect causes severe defoliation.

An undetermined plant louse is at an epidemic level attacking dwarf ash at the Colorado National Monument. Attempts at control are advisable.

COOPERATION

The role of the cooperator in forest insect surveys is very substantial. He is a major factor in detecting insects at the incipient outbreak level and reporting his observations to the laboratory. This sort of cooperation has been part of the survey program of the Fort Collins laboratory for many years. An increase in cooperation is developing as the laboratory enlarges its program for training foresters in insect detection. The aim is to familiarize all foresters with the harmful forest insects they are apt to meet, to impress upon everyone in the woods the need for an early report of each observation, and to provide the forester with a simple but complete means of reporting his observations. This aim, actively shared by all the cooperators, is gradually being shaped into reality.

The Rocky Mountain Forest Pest Advisory Committee, organized in 1952, will aid materially in advancing surveys of forest insect conditions within the territory of the Fort Collins laboratory. This committee is composed of private and public agencies and individuals concerned with forest protection and forest management. Its proposed sphere of direct influence is within the administrative boundaries of Region 2, U. S. Forest Service, and the States of Montana, Arizona, and New Mexico.

The Committee will review the annual reports of forest insect conditions and assist in the preparation of action programs. It will promote coordination of ideas and cooperation on actions, thus perfecting surveys and control.

SURVEY IMPROVEMENT STUDIES

Studies were initiated to improve survey methods so as to increase the range, accuracy, and overall efficiency of surveys. These and other studies will be

continued. The improvements of survey methods made at the other field laboratories will be incorporated with or used to supplement the methods now in practice at the Fort Collins laboratory, if such adaptability is deemed advisable for the field and insect conditions in the Central Rockies or the Great Plains.

A study on plot size most adaptable to surveys of Engelmann spruce beetle outbreaks in the Central Rockies confirmed the 1/10-acre plot as being most feasible.

A similar study was made toward determining the survey method best used for Black Hills beetle infestations in ponderosa pine stands of the Central Rockies. The use of ½-chain strips was selected over the equally accurate cruise lines of 1/10-acre plots, on the basis that it is simpler to train personnel to survey by a strip method.

A study to analyze the variables that affect sampling errors in surveying Black Hills beetle infestations in ponderosa pine was carried out. It was found that sampling error is related significantly to percent of survey and to size of the area surveyed.

A study was initiated to predict trends in Black Hills beetle populations. Two 240-acre permanent plots were established in ponderosa pine stands and beetle population counts were made on a number of infested trees on each plot. Population counts will be made periodically on these plots for several years; additional plots will be established in 1953.

A study toward developing an aerial method of estimating the number of trees killed by the Black Hills beetle was continued. Ground counts of all beetle-killed trees, by year of kill, were made on two areas. Two separate surveys were made from the air. Tallying red-tops by operation recorder on strips covering 50 percent of the area gives fair estimates. Counting red-tops on Ektachrome film exposed at 7,920 feet above the ground results in far better results.

Table 1. FOREST INSECT CONDITIONS IN THE CENTRAL ROCKY MOUNTAINS AND THE GREAT PLAINS - 1952

General Area	Insect	Host	Infestation Status (trees)	Suggested Action
Colorado				
White River N. F.) Arapaho N. F.) Routt N. F.)	Engelmann spruce beetle	Engelmann spruce	mop-up	EDB[1/] and trap logs
Rio Grande N. F.	Engelmann spruce beetle	Engelmann spruce	mop-up	EDB and salvage logging
	Black Hills beetle	Ponderosa pine	500	EDB and salvage logging
	Great Basin tent caterpillar	Aspen	15,000+ acres	DDT airplane or mist-blower
San Juan N. F.	Engelmann spruce beetle	Engelmann spruce	mop-up	EDB and salvage logging
	Black Hills beetle	Ponderosa pine	1,200	EDB and salvage logging
Roosevelt N. F.	Black Hills beetle	Ponderosa pine	8,000	EDB and salvage logging
Uncompahgre N. F.	Black Hills beetle	Ponderosa pine	1,100	EDB and salvage logging
San Isabel N. F.	Black Hills beetle	Ponderosa pine	800	EDB and salvage logging
	Great Basin tent caterpillar	Aspen	20,000+ acres	DDT airplane or mist blower
Pike N. F.	Black Hills beetle	Ponderosa pine	125+	EDB and salvage logging
Mesa Verde N. P.	Pinon sawfly	Pinon		DDT by mist-blower
	Pinon scale	pinon		Dendrol (tests)
	Great Basin tent caterpillar	Bitterbrush, mountain mahogany, and serviceberry		DDT by mist-blower

Colorado Nat'l. Mon.	Pinon sawfly	Pinon		DDT by mist-blower
	Pinon scale	Pinon		Dendrol (tests)
	Tip moth	Pinon		Cutting out infested tips
	Plant louse	Ash		To be determined
South Dakota				
Black Hills N.F.	Black Hills beetle	Ponderosa pine	500	EDB or ODB[2/] and salvage logging
	Poplar and willow borer	Willow		To be determined
Harney N.F.	Black Hills beetle	Ponderosa pine	390	EDB or ODB and salvage logging
Wyoming				
Bighorn N.F.	Black Hills beetle	Ponderosa pine	1,346	EDB or ODB and salvage logging
Nebraska				
Nebraska N.F.	Turpentine beetle	Scotch, Austrian, ponderosa, and jack pines	150	DDT and ODB
	Twig moth	Austrian and Scotch pine		Cutting out infested tips
Chadron State Park	Tussock moth	Ponderosa pine		DDT emulsion spray

1/ Ethylene dibromide emulsion
2/ Orthodichlorobenzene and fuel oil

Table 2. FOREST INSECT CONTROL PROJECTS IN THE CENTRAL ROCKY MOUNTAINS AND THE GREAT PLAINS - 1952

General Area	Control Agency	Insect	Host	Control Method	Accomplishment (trees)
Colorado					
White River N.F.) Arapaho N.F.) Routt N.F.)	U.S. Forest Service	Engelmann spruce beetle	Engelmann spruce	ODB[1] or EDB[2] by stirrup pump	227,859
Rio Grande N.F.	U.S. Forest Service	Engelmann spruce beetle	Engelmann spruce	ODB or EDB by stirrup pump	2,108
	U.S. Forest Service	Black Hills beetle	Ponderosa pine	" " "	178
San Juan N.F.	U.S. Forest Service	Engelmann spruce beetle	Engelmann spruce	" " "	4,182
	U.S. Forest Service	Black Hills beetle	Ponderosa pine	" " "	220
San Isabel N.F.	U.S. Forest Service	Black Hills beetle	Ponderosa pine	" " "	96
Mesa Verde N.P.	Nat'l. Park Service	Pinon sawfly	Pinon	DDT by mist-blower	Accessible infested area
	Nat'l. Park Service	Great Basin tent caterpillar	Bitterbrush, mountain mahogany, serviceberry	" " "	" "
Colorado N.M.	Nat'l. Park Service	Pinon sawfly	Pinon	" " "	" "
	Nat'l. Park Service	Pinon scale	Pinon	Dendrol by mist-blower	
South Dakota					
Black Hills N.F.	U.S. Forest Service	Black Hills beetle	Ponderosa pine	ODB by stirrup pump	335
Harney N.F.	U.S. Forest Service	Black Hills beetle	Ponderosa pine	" " " "	193

1/ Orthodichlorobenzene and fuel oil
2/ Ethylene dibromide emulsion